WE CLAIM:

1. A method of forming a silicon-containing compound layer in an integrated circuit, the method comprising a plurality of cycles, each cycle comprising:

depositing a silicon layer on a substrate in a process chamber by exposing the substrate to trisilane;

substantially removing the trisilane from the process chamber;

forming a silicon-containing compound layer by exposing the silicon layer to a reactive species; and

substantially removing the reactive species from the process chamber.

2. The method of Claim 1, wherein the reaction chamber is a single substrate laminar flow reaction chamber.

3. The method of Claim 1, wherein the reaction chamber is a batch reactor.

4. The method of Claim 1, wherein depositing a silicon layer comprises chemical vapor deposition.

5. The method of Claim 1, wherein depositing the silicon layer comprises forming more than one atomic layer of silicon.

6. The method of Claim 1, wherein the reactive species comprises a nitrogen species and the silicon-containing compound layer comprises silicon nitride.

7. The method of Claim 6, wherein the nitrogen species comprises ammonia.

8. The method of Claim 6, wherein the nitrogen species comprises nitrogen active species.

9. The method of Claim 6, wherein the silicon nitride layer is more uniform than a silicon nitride layer of substantially similar thickness deposited by chemical vapor deposition with silane.

10. The method of Claim 6, wherein the silicon nitride layer is formed over an interfacial layer.

11. The method of Claim 10, wherein the interfacial layer comprises silicon oxynitride.

12. The method of Claim 10, wherein the interfacial layer comprises silicon oxide.

13. The method of Claim 10, wherein the interfacial layer is formed by thermal oxidation.

14. The method of Claim 10, wherein the interfacial layer is formed by a process comprising:

depositing a silicon layer on a substrate by exposing the substrate to trisilane; and

forming the interfacial layer by exposing the silicon layer to an oxygen species.

15. The method of Claim 14, wherein the oxygen species comprises one or more oxidants selected from the group consisting of atomic oxygen, water, ozone, oxygen, nitric oxide, and nitrous oxide.

16. The method of Claim 1, wherein the silicon-containing compound layer is formed over a hydrogen passivated substrate.

17. The method of Claim 1, wherein substantially removing the trisilane comprises a removal process chosen from the group consisting of evacuating the process chamber and purging the process chamber with inert gas.

18. The method of Claim 1, wherein substantially removing the reactive species comprises a removal process chosen from the group consisting of evacuating the reactive species and purging the process chamber with inert gas.

19. The method of Claim 1, wherein the cycles are repeated until the silicon-containing compound layer has a thickness between about 3 Å and 5000 Å.

20. The method of Claim 19, wherein the cycles are repeated until the thickness is between about 3 Å and 400 Å.

21. The method of Claim 1, wherein the silicon-containing compound layer has a thickness non-uniformity of about 5% or less.

22. The method of Claim 21, wherein the silicon-containing compound layer has a step coverage of about 80% or greater.

23. A method of forming an insulating film, comprising:

loading a substrate into a reaction chamber;

forming a silicon film by exposing the substrate to a silicon source, wherein the silicon source for forming a first silicon film on the substrate, after loading the substrate, is a polysilane;

substantially removing the silicon source from the reaction chamber;

exposing the silicon film to a nitrogen source to form a silicon nitride film; and

substantially removing the nitrogen source from the reaction chamber.

24. The method of Claim 23, wherein the silicon source comprises one or more compounds selected from the group consisting of disilane and trisilane.

25. The method of Claim 24, further comprising augmenting a silicon nitride film thickness by forming a silicon nitride layer directly over the silicon nitride film by a further CVD process in which silicon and nitrogen precursors are simultaneously introduced into the reaction chamber.

26. The method of Claim 25, further comprising forming a silicon nitride sealing layer directly over the further silicon nitride layer, wherein the silicon nitride sealing layer is formed by a method comprising:

forming a silicon layer by exposing the substrate to a silicon source comprising trisilane;

substantially removing the silicon source from the reaction chamber;

exposing the silicon layer to a nitrogen source; and

substantially removing the nitrogen source from the reaction chamber.

27. The method of Claim 23, wherein forming a silicon film, substantially removing the silicon source, exposing the silicon film to a nitrogen source, and substantially removing the nitrogen source are repeated in sequence until a silicon nitride film of a desired thickness is formed.

28. The method of Claim 27, wherein the silicon source for forming silicon films after forming a first silicon film comprises a compound having a chemical formula Si_nH_{2n+2}, wherein n is equal to a number from 1 to 4.

29. The method of Claim 27, wherein a halosilane replaces trisilane as the silicon source after a first silicon film is formed.

30. The method of Claim 23, wherein the first silicon film has a thickness of at least about a nitridation saturation depth.

31. The method of Claim 30, wherein the nitridation saturation depth is a short-term nitridation saturation depth.

32. The method of Claim 30, wherein the nitridation saturation depth is between about 3 Å and 30 Å.

33. The method of Claim 23, wherein a ratio of silicon atoms and nitrogen atoms comprising the silicon nitride film is substantially stoichiometric.

34. The method of Claim 33, wherein the silicon nitride film has less than about 0.2 atomic percent incorporated hydrogen.

35. The method of Claim 34, wherein the silicon nitride film has less leakage current than a similar silicon nitride film formed by a CVD process in which silicon and nitrogen precursors are simultaneously introduced into the reaction chamber.

36. The method of Claim 23, wherein the silicon nitride film has a higher dielectric constant than another silicon nitride film deposited by a CVD process in which silicon and nitrogen precursors are simultaneously introduced into the reaction chamber.

37. The method of Claim 23, wherein forming a silicon film comprises decomposing the silicon source to form the silicon film with a thickness non-uniformity of about 10 percent or less and a step coverage of about 70% or greater.

38. A method of forming a layer, of an insulating silicon compound, having a desired thickness for an integrated circuit by performing multiple chemical vapor deposition cycles in a reaction chamber, each cycle comprising:

first, depositing a silicon layer on a substrate by exposing the substrate to a silicon source, wherein the silicon layer has a silicon layer thickness between about 3 Å and 25 Å; and

second, reacting the silicon layer to partially form the layer of an insulating silicon compound, wherein a temperature for reacting is less than about 650°C.

39. The method of Claim 38, wherein reacting comprises nitriding and wherein the insulating silicon compound is silicon nitride.

40. The method of Claim 39, wherein the layer of an insulating silicon compound has a stoichiometry of about 43 silicon atoms per 56 nitrogen atoms.

41. The method of Claim 38, wherein reacting comprises oxidizing and wherein the insulating silicon compound is silicon oxide.

42. The method of Claim 38, wherein trisilane is the silicon source used to deposit a first silicon layer on the substrate in a first performance of a cycle.

43. The method of Claim 42, wherein the silicon source for depositing subsequent silicon layers after depositing the first silicon layer comprises a silicon compound selected from the group consisting of silanes having a silane chemical formula Si_nH_{2n+2}, where n = 1 to 4, and halosilanes having a halosilane chemical formula $R_{4-X}SiH_X$, where R = Cl, Br or I and X = 0 to 3.

44. The method of Claim 43, wherein all silicon layers deposited after the first silicon layer are formed with the same silicon source.

45. The method of Claim 43, wherein a first substrate temperature for depositing the first silicon layer is less than about 525°C.

46. The method of Claim 45, wherein the first substrate temperature is less than about 475°C.

47. The method of Claim 46, wherein a second substrate temperature for reacting the first silicon layer is greater than the first substrate temperature.

48. The method of Claim 47, wherein depositing and reacting are performed isothermally after reacting the first silicon layer.

49. The method of Claim 48, wherein a third substrate temperature for depositing and reacting, after reacting the first silicon layer, is between about 400°C and 650°C.

50. The method of Claim 49, wherein the third substrate temperature is greater than about 525°C.

51. The method of Claim 47, further comprising evacuating the reaction chamber for at least about 10 seconds before reacting the first silicon layer.

52. The method of Claim 47, wherein the first silicon layer has a first silicon layer thickness of about 8-12 Å.

53. The method of Claim 52, wherein a temperature and a duration for reacting are chosen to prevent reacting the substrate under the silicon layer.

54. The method of Claim 52, wherein reacting the silicon layer comprises exposing the silicon layer to an atomic species.

55. The method of Claim 54, wherein the atomic species is atomic nitrogen.

56. The method of Claim 38, wherein the reaction chamber is a single substrate laminar flow reaction chamber.

57. The method of Claim 38, wherein the reaction chamber is a batch reactor.

58. A process of forming a silicon nitride layer on a substrate, comprising:

loading a substrate having a crystalline silicon surface into a single substrate laminar flow process chamber;

forming a silicon layer on the crystalline silicon surface by decomposing a silicon source comprising a polysilane, wherein the polysilane has a chemical formula Si_nH_{2n+2}, where n = 2 to 4;

nitriding the silicon layer to form a silicon nitride layer by flowing a nitrogen source into the process chamber after forming the silicon layer; and

repeating forming a silicon layer and nitriding the silicon layer until a silicon nitride layer of between about 3 Å and 1000 Å thick results.

59. The process of Claim 58, wherein forming the silicon layer occurs substantially while the process chamber is substantially free of a precursor used for nitriding the silicon layer and wherein nitriding the silicon layer occurs substantially while the process chamber is substantially free of the polysilane.

60. The process of Claim 58, wherein the silicon source comprises trisilane.

61. The process of Claim 60, wherein forming a silicon layer comprises depositing trisilane within a mass transport limited regime.

62. The process of Claim 58, further comprising making the process chamber substantially free of the silicon source by evacuating the process chamber directly after forming a silicon layer.

63. The process of Claim 58, further comprising making the process chamber substantially free of the silicon source by purging the process chamber directly after forming a silicon layer.

64. The process of Claim 58, further comprising making the process chamber substantially free of the silicon source by flowing the nitrogen source into the process chamber directly after forming a silicon layer.

65. The process of Claim 58, further comprising making the process chamber substantially free of the nitrogen source by flowing the silicon source into the process chamber directly after forming a silicon layer.

66. The process of Claim 58, wherein a first silicon layer formed by decomposing the silicon source has a thickness of at least about a nitridation saturation depth.

67. The process of Claim 58, wherein nitriding the silicon layer leaves the crystalline silicon surface substantially free of nitrogen.

68. The process of Claim 58, wherein a substrate temperature is between about 400°C and 750°C.

69. The process of Claim 68, wherein the substrate temperature is between about 450°C and 650°C.

70. The process of Claim 68, wherein depositing and forming are performed isothermally.

71. The process of Claim 68, wherein a process chamber pressure is between about 0.001 Torr and 100 Torr.

72. The process of Claim 71, wherein a process chamber pressure is between about 0.01 Torr and 10 Torr.

73. The process of Claim 71, wherein depositing and forming are performed isobarically.

74. The process of Claim 58, wherein a hydrogen concentration of the silicon nitride layer is less than about 0.2 atomic percent.

75. The process of Claim 58, further comprising forming a gate electrode over the silicon nitride layer.

76. A method of forming a silicon nitride film, comprising:

loading a substrate into a reaction chamber;

chemical vapor depositing a silicon layer on the substrate, wherein the silicon layer has a thickness non-uniformity of about 5% or less and a height of a top surface of the silicon layer over the substrate is greater than about a nitridation satuaration depth; and

nitriding the silicon layer.

77. The method of Claim 76, wherein chemical vapor depositing a silicon layer and nitriding the silicon layer are sequentially repeated until a silicon nitride film of a desired thickness results.

78. The method of Claim 77, wherein chemical vapor depositing occurs while the reaction chamber is substantially free of a second precursor used for nitriding and wherein nitriding occurs while the reaction chamber is substantially free of a first precursor used for depositing.

79. The method of Claim 76, wherein chemical vapor depositing is performed using a silicon precursor having a chemical formula Si_nH_{2n+2}, where n = 2 to 4.

80. The method of Claim 79, wherein the silicon precursor is trisilane.

81. The method of Claim 76, wherein the silicon layer has a thickness non-uniformity of about 1% or less.

82. The method of Claim 76, wherein the silicon-containing compound layer has a surface roughness that is greater than the substrate roughness by about 5 Å rms or less, over a surface area of about one square micron or greater.

83. The method of Claim 76, wherein the substrate comprises a step or trench.

84. The method of Claim 83, wherein the step has an aspect ratio of about 4.5 to 6.

85. The method of Claim 84, wherein the silicon nitride film has a step coverage of about 70 percent or greater.

86. The method of Claim 85, wherein the silicon nitride film has a step coverage of about 80 percent or greater.

87. The method of Claim 83, wherein the step has an aspect ration of about 1 to 4.

88. The method of Claim 87, wherein the silicon nitride film has a step coverage of about 80 percent or greater.

89. The method of Claim 89, wherein the silicon nitride film has a step coverage of about 90 percent or greater.

90. The method of Claim 76, wherein the thickness of the silicon layer is between about 3 Å and 25 Å.

91. The method of Claim 76, wherein the reaction chamber is a single substrate laminar flow reaction chamber.

92. An integrated circuit, comprising:

an insulating layer of a silicon compound over a substrate,

wherein the layer has a thickness non-uniformity of about 10 percent or less and a hydrogen concentration of less than about 2 atomic percent.

93. The integrated circuit of Claim 92, wherein the insulating layer comprises silicon nitride.

94. The integrated circuit of Claim 93, wherein a ratio of silicon and nitrogen in the insulating layer is substantially stoichiometric.

95. The integrated circuit of Claim 92, further comprising a crystalline silicon surface beneath the insulating layer, wherein the silicon surface is surface is substantially free of nitrogen.

96. The integrated circuit of Claim 92, wherein the insulating layer comprises silicon oxide.

97. The integrated circuit of Claim 92, wherein the insulating layer comprises silicon oxynitride.

98. The integrated circuit of Claim 92, wherein the thickness non-uniformity is about 10% or less.

99. The integrated circuit of Claim 98, wherein the thickness non-uniformity is about 5% or less.

100. The integrated circuit of Claim 99, wherein the thickness non-uniformity is about 2% or less.

101. The integrated circuit of Claim 92, wherein the hydrogen concentration is less than about 1 atomic percent.

102. The integrated circuit of Claim 100, wherein the hydrogen concentration is less than about 0.5 atomic percent.

103. The integrated circuit of Claim 102, wherein the hydrogen concentration is less than about 0.2 atomic percent.

104. The integrated circuit of Claim 92, wherein a surface roughness of the insulating layer is greater than a substrate surface roughness by about 5 Å or less.